NATIONAL INFRASTRUCTURE COMMISSION

Young Professionals Panel

4th February 2022

YPP response to NIA2 Baseline report call for evidence

Dear National Infrastructure Commission NIA2 team,

We are writing in response to your call for evidence on the second National Infrastructure Assessment (NIA2) baseline report. This submission is non-confidential and may be published on your website.

The National Infrastructure Commission's Young Professionals Panel (YPP) supports and informs the Commission's work, providing a voice for future generations in long-term infrastructure planning. By doing so, the YPP aims to ensure that the decisions made today account for the interests of both current and future generations. This has never been more critical. The challenges of climate change and biodiversity loss are unprecedented in nature and complexity, and we may already be too late to avoid a 1.5°C rise in global temperatures in 2040. At the same time, large geographical disparities in outcomes across the UK means that the future of both young people today and in the future are subject to a postcode lottery.

Infrastructure has a key role to play in shaping the future we want to see across net zero, quality of life, and equality of outcomes. NIA2 comes at a time where we need to take action to build this future. We support the NIC's work in establishing a clear starting point for its recommendations and look forward to seeing it set out clear, decisive action in its final recommendations.

The YPP has already provided some input into this baseline report as part of the NIA2 expert advisory panels. We now set out our response to questions in the call for evidence informed by both our own experiences and engagement with young people both within and outside of the infrastructure sector.

Sincerely,

The National Infrastructure Commission Young Professionals Panel

Q1. Do the nine challenges identified by the Commission cover the most pressing issues that economic infrastructure will face over the next 30 years? If not, what other challenges should the Commission consider?

The YPP agrees that the three overarching themes reflect the priority areas for infrastructure over the long-term. However, the individual challenges risk as they currently stand risk overlooking some critical areas, namely **biodiversity and quality of life**.

Biodiversity

The recent Dasgupta Review has highlighted the need to act now on biodiversity loss. This is reflected in the baseline report which repeated references biodiversity as part of the 'climate resilience and environment theme'. However, there is a lack of consideration of biodiversity within the challenges themselves. For example:

- **Waste and the circular economy**. This challenge seems to focus on recycling rates and restrictions on waste exports with no explicit consideration of biodiversity associated with circular solutions.
- **Asset management and resilience**. This challenge focuses on improving resilience within our asset stock to manage the impact of climate change. Solutions to address resilience can either support or undermine biodiversity. For example, natured based solutions such as wetlands restoration can be used for flood management while restoring habitats. On the other hand, replacement of aging assets with traditional grey infrastructure offer limited biodiversity benefits. This trade-off should be explicitly considered when making recommendations on asset management.
- **Surface water management**. As above, nature based solutions can be used as a solution to surface water management but it is not clear how the relative value of biodiversity co-benefits will be considered as part of the options evaluation for 'greatest resilience and value for money.'

The NIC's recommendations align with wider policy requirements around biodiversity including the recent Environment Bill. This should include an explicit requirement to consider biodiversity across all its recommendations, including placing a monetary value on biodiversity were possible as part of any cost-benefit evaluation. There are likely to be learnings from other jurisdictions such as the Scottish Environment Protection Agency who already account for biodiversity in their decision-making.

Quality of life

The second area that merits greater focus is the role of infrastructure in improving quality of life metrics beyond productivity as part of the levelling-up agenda. The recent levelling-up whitepaper has evaluated levelling-up on a 6 capitals basis and it is now clear that levelling-up goes beyond productivity alone. This echoes the feedback from previous YPP engagement which found that whilst income is a key factor in quality of life, it is not the only factor. For example, there was widespread support for greater provision of green spaces, access to which varies significantly by geography and demographic group, to support mental and physical health and could support the biodiversity agenda.

We are aware that the NIC is currently carrying out a study into quality of life outside of the NIA2 work. The outcomes of this work should be explicitly incorporated into the scope of the 9 challenges. To strike a reasonable balance, we recommend **focusing on key trade-offs across quality of life metrics that society currently face,** for example trade-offs between air quality (health) and proximity to transport, or access to green space vs. income. This should include a mapping exercise against existing quality of life indicators e.g. ONS Measures of National wellbeing or index of multiple deprivation, which may fall within the ongoing quality of life research. We also look forward to the outcomes of Challenge 1 (digital) and its role in the levelling up agenda.

Deliverability

We also recommend that the NIC considers its recommendations in light of the ongoing infrastructure skills shortage, identify where supply chains require additional support to deliver against its ambitions, and engage with BEIS and other relevant stakeholders to address these shortages.

Q2. What changes to funding policy help address the Commission's nine challenges and what evidence is there to support this? Your response can cover any number of the Commission's challenges.

The YPP has previously discussed the challenges of our current centralised funding system. Whilst a more centralised approach may be merited for large-scale projects, the upfront costs of the business case submission process is disproportionate for smaller-scale local infrastructure projects and remains a major hurdle for accessing funding. Beyond the financial cost of developing a business case, the process also requires time and expertise from local projects teams that are already often under-resourced. This was raised as part of our research on Local Area Energy Planning. Our research, along with the results from the Local Heat Energy Efficiency[1] pilot undertaken by the Scottish Government showed that local authorities had limited resources and skills to develop local plans. Significant support was required from external consultants.

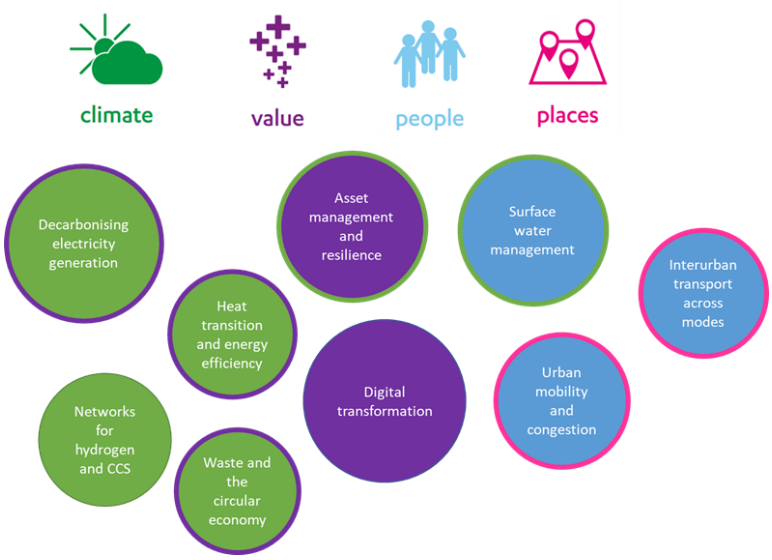
We strongly agree with the NIC's recommendations on devolved local funding and hope to see this reiterated in NIA2. Furthermore, we hope that the NIC is clear that where funding is moved to a devolved basis, this does not replace existing regional settlements or funding pots, leading to an overall reduction in available funding. Ultimately any changes in funding will need to be transparent.

Specifically in relation to net-zero, we see a need to align funding policies and priorities across sectors. Whilst the Government has set out a net-zero plan, there is little practical detail on how this will be achieved by individual sectors nor how aggrege UK targets apply to individual sectors. This leaves ambiguity for funding decisions that hampers investment into net zero and could jeopardise overall achievement of targets particularly around scope 3 emissions.

Q3. How can better design, in line with the design principles for national infrastructure, help solve any of the Commission's nine challenges for the next Assessment and what evidence is there to support this? Your response can cover any number of the Commission's challenges.

To quote the NIC "*design is as much about the process as the product*". The design principles help develop a vision for the intended outcomes of a project. Casting the net wider than the central purpose can provide wider benefits to communities and ensure the scheme is compatible to wider policies on climate change, levelling up and placemaking. The fundamental intersection of these three policies in providing benefits to communities should be embedded in the design and planning of any infrastructure scheme. When projects set out their vision and purpose for a project they recognise opportunities for co-benefits. Examples include Boston Barrier, Fens reservoir, Pooley Bridge replacement and Cambridge WRC relocation (case studies below). We see opportunities to deploy the design principles across all 9 challenges as set out below.

Figure 1.1: Mapping the design principles to NIA2 challenges



[1] https://www.gov.scot/publications/synthesis-evaluation-local-heat-energy-efficiency-strategy-lhees-pilot-programme/

The National Infrastructure Strategy (published in November 2020) points out that as well as being vital for the economy and productivity growth, infrastructure is also a key driver of public health outcomes. The benefits and negative impacts are not equally distributed across society and / or at a spatial level. This means that deprived areas and some parts of the population are usually disproportionally affected by infrastructure schemes or investments. For example, communities who live closest to motorways are affected by long term exposure to air pollution, are usually the most deprived; flooding tends to affect the most deprived areas and similarly fuel poverty affects the most vulnerable in society. It is therefore important that infrastructure design reflects on these spatial inequalities, which are not just socio-economics but include health and quality of life issues (see our response to Q1 on quality of life).

Boston Barrier – Tidal flood defence in Boston, Lincolnshire

Boston Barrier's core purpose was to provide 14,000 properties better protection to tidal flooding. However, the team used the United Nations Sustainable Development Goals (SDGs) as a basis for monitoring and evaluating success, incorporating them where possible to help improve the project. This maximised the project's benefits by supporting greater outcomes for the local community.

The project became much more than a flood defence scheme, it has been estimated it could help deliver over £1 billion in economic benefits to Boston town and wider area by encouraging investment, improving resilience and well-being and by protecting historic assets. The construction team made it a priority to spend locally where they could and have invested over £7 million in the local economy within a 50 mile radius of the site to date (April 2021).

Whilst this scheme didn't use the design principles, using the SDGs to create a vision, the project identified small changes that ensured wider benefits could be achieved.

Pooley Bridge Replacement – Connecting communities in Ullswater valley, Cumbria

Following destruction of the original stone Grade-II listed packhorse-bridge, the Pooley Bridge community was left divided. The core purpose of this scheme was to provide a replacement bridge which would cope better in flood events. The scheme was sensitive to placemaking, taking the time to conduct meaningful stakeholder engagement with the community focusing on their common aspirations to come up with a design that would be fit for purpose but provided an essence of local identity and in keeping with the Lakeland-setting.

The scheme considered whole life cost and carbon – picking a 100% recyclable material and specifying specific steel which had 1/5 of the embodied carbon of the global average of stainless-steel.

Fens reservoir – securing future water supplies and drought resilience to the Anglian region

Whilst still in the concept design stage, the Fens Reservoir scheme have embraced the design principles and have actively looked for wider benefits to be delivered through the scheme. The core purpose of the scheme is to provide 1:500 year drought resilience however the project team have identified there could be opportunities for environmental enhancement, such as reduction of abstraction in chalk streams, contributing to the alleviation of flood risk, positive social outcomes, improved climate resilience, and realisation of low carbon targets.

By realising cross-sector opportunities and applying integrated water management principles to water management, they have proposed a multi-purpose reservoir to capture flood flows (providing flood risk benefits) and supply irrigation demand alongside potable water services. This would support the local economy by offering water for irrigation and improving the attractiveness of the area as a tourism destination.

Q4. What interactions exist between addressing the Commission's nine challenges for the next Assessment and the government's target to halt biodiversity loss by 2030 and implement biodiversity net gain? Your response can cover any number of the Commission's challenges.

The strategy to 'build back better' gave many a carbon consultant and environmentalist concerns over the alignment between achieving net zero and halting biodiversity policies. If you look at the carbon management hierarchy: build nothing, build less, build clever, build efficiently, offset, the same principles can be applied to biodiversity. Many of the solutions to the NIA2 challenges will see creation of new assets – increasing embodied carbon and possible loss of biodiversity where assets are built on greenfield sites. As recommended in Q1, biodiversity needs to be considered in recommendations as much as net-zero.

As part of the circular economy or natural capital elements of the NIA2, some consideration to land use would help manage the need for new assets without compromising biodiversity. The funds announced in the autumn 2021 budget for brownfield redevelopment was promising however as an industry we still lack a truly 'brownfield first' approach to planning policy which means our green spaces and country side are often built on before renovating existing assets or utilisation brownfield sites have been considered.

Year	Number of sites	Hectares
2021	21,566	26,256
2020	20,750	24,684
2019	18,277	26,002
2018	17,656	28,349
Difference (2018-2021)	+3,910	-2,201

Source: local authority brownfield land registers (Recycling our land: state of brownfield 2021, CPRE, November 2021)

The use of natural capital and ecosystem services to measure loss and creation of natural assets through infrastructure projects would provide a better understanding of the harm or environmental benefits our infrastructure programme is delivering. Measures such as carbon storage, natural hazard management, and air pollutant removal should be of interest to the National Infrastructure Commission to ensure quality of life, achievement of net zero ambitions and providing natural resilience to flooding and droughts. Taking a more holistic systems approach to these challenges rather than ignoring the non-engineered solutions ignores the significant contribution natural systems can provide which are often low carbon and low cost solutions.

Q5. What are the main opportunities in terms of governance, policy, regulation and market mechanisms that may help solve any of the Commission's nine challenges for the Next Assessment? What are the main barriers? Your response can cover any number of the Commission's challenges.

As we set out above, we view ongoing devolution of funding is a key driver to take a place based approach and reflect local needs. This will allow organisations to pick the best solution for the individual problem and maximise value for money for society. We also re-emphasise the need to ensure alignment on policies across different sectors. The recent Government policy paper[2] on economic regulation highlights divergence across the utilities sectors and the risk this poses to achievement of our net-zero and interim carbon targets.

We will also need to continue the emphasis on adaptive planning, acknowledging that uncertainty is simply part of normal business planning and allowing regulation to be reactive to large market changes. Our regulatory regime must offer more flexibility to account for uncertain investments. For example, in the energy sector, Frerk3 and Zachary et al.'s4 papers, as well as Professor Cloda Jenkins' oral evidence to the Industry and Regulators Committee suggest that analysis tools are required to support decision making, Where judgements and risks are increasingly required by the regulator. These judgements must take a forward-looking approach to consider biodiversity and net zero rather than relying simply on the past.

[2] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1051261/economic-regulation-policy-paper.pdf

[3] https://www.oxfordmartin.ox.ac.uk/publications/investing-for-net-zero-in-the-face-of-uncertainty-real-options-and-robust-decision-making/

[4] https://www.ofgem.gov.uk/publications/decision-making-future-energy-systems

Q6. In which of the Commission's sectors (outside of digital) can digital services and technologies enabled by fixed and wireless communications networks deliver the biggest benefits and how much would this cost?

The use of digital tools and new technologies has the potential to improve services, increase efficiency and reliability, and improve neighbourhoods across multiple sectors. Improved use of smart metering data can better forecast peak load needs, resulting in better management of electricity generation; remote sensors that can monitor equipment performance; transit-oriented developments where frequency and speed of transport means depends on the number of people in the local area. Digitalisation of infrastructure services also represents an opportunity to tackle spatial inequalities, addressing maintenance requirements efficiently, improving distribution of services and resources to lower income neighbourhoods and towns as well as contributing to forming resilient communities.

Main sectors where digitalisation would deliver the biggest benefits:

- **Energy**. Limits to the adoption of smart meters include low reliability of internet connection, particularly in rural areas where low reliability hinders the capabilities of smart meters and discourages uptake. This remains a key barrier to flexibility-based solutions to moving to a green-economy such as network demand management, as well as more innovative solutions such as returning energy from EVs to the grid.

  A study to explore the return of investment in low carbon energy initiatives is being conducted in the Borderlands region – the Borderlands Strategic Low Carbon Energy Masterplan. This will consider the social impacts of investment in these initiatives, such as improvements to air quality, addressing fuel poverty, and the opportunity to create high value jobs for local people. Once published (expected June 2022), this study should be used as a benchmark to identifying costs and potential benefits of similar low carbon, smart energy solutions.

- **Asset management.** Management of infrastructure assets would greatly benefit from greater digitalisation to enable a more circular approach to our infrastructure assets. This would allow us to map assets, monitor maintenance requirements and damages effectively and efficiently. This would apply to any infrastructure asset – water or gas pipes, roads, railway tracks, electricity cables. The initial high costs of applying this approach would be absorbed in the long term by getting the best value out of existing assets, enhancing assets performance, saving through early maintenance. Further details of this are provided in answer to Q7, Q14 and Q15.

- **Skills gap.** As we previously mentioned, infrastructure faces a major skills gap which threatens the deliverability of long-term plans. Improved use of digital innvoations can help address short-medium term challenges by increasing capacity and capability of our existing workforce, as well as attracting talent to the sector in the long-term.

Q7. What barriers exist that are preventing the widescale adoption and application of these new digital services and technologies to deliver better infrastructure services? And how might they be addressed? Your response can cover any number of the Commission's sectors outside digital (energy, water, flood resilience, waste, transport).

Digitalising physical infrastructure assets and services (see the response to Q13) will require both the streaming of significant amounts of data, and real-time computations to translate this data into metrics that are physically meaningful. This, in turn, requires adequate network coverage and energy. Network coverage is increasingly not an issue thanks to the quality of 4G (and, in the future, 5G) networks; however, widespread adoption of digital services, such as asset sensing across infrastructure networks, could substantially increase the demand for bandwidth in these networks. Energy demand will also rise. Although this is noted in passing in the Commission's Baseline Report, the scale of this rise in demand remains highly uncertain. Consequently, it is unclear what the indirect carbon costs of these digital services will be and how easy it will be to mitigate these as the energy sector moves towards net zero carbon.

Secondly, the digitalisation of infrastructure services could lead to these services becoming increasingly reliant on the availability/reliability of digital communications networks. The security of these communications networks - and the cybersecurity of the newly digitalised infrastructure services - will

need to be considered and backup systems developed, particularly when issues of user safety could arise in instances of service failure/downtime.

Aside from physical infrastructure barriers, there remains a data skills gap that will need to be addressed in parallel with the NIA2 recommendations in order for the Commission's recommendations to be feasibly operationalised.

Q8. What are the greatest risks to security of supply in a decarbonised power system that meets government ambition for 2035 and what solutions exist to mitigate these risks?

The UK and Scottish Governments have set ambitious targets for renewable generation to meet 2050 and 2035 targets. Whilst a decarbonised power system has its challenges in supply intermittency, better connectivity to transfer energy to areas of high demand through reinforced networks can mitigate some of these risks. There is a real risk that network infrastructure is not developed at pace, and will not enable the transfer of renewable energy from areas of generation to areas of high demand.

The NIC pointed out in its report on Strategic Investment and Public Confidence that regulators must adapt to new challenges (ie Net Zero) which it did was not originally designed to tackle. Regulators must increasingly take risks and judgements to enable delivery of network reinforcement to take place at pace.

Whilst the Government and Ofgem have introduced the inception of a Future System Operator (FSO), it will be important as part of this work to consider not only the remit of the FSO, but the tools the current ESO is using to manage the system. Many of these tools and policies, such as CBA analysis that only considers constraint and capital costs, TNUoS, ancillary and balancing mechanisms, etc. Were developed over 30 years ago in a world where Net Zero was not a guiding principle and target. These tools must be considered and re-assessed if they continue to be fit for purpose to ensure the energy system is being incentivised and managed to enable Net Zero. We must also be vigilant that network planning assumptions are not overly optimistic on demand-side solutions that rely on large-scale behavioural change e.g. returning energy to the grid from EVs to smooth network demand.

Q9. What evidence do you have on the barriers to converting the existing gas grid to hydrogen, installing heat pumps in different types of properties, or rolling out low carbon heat networks? What are the potential solutions to these barriers?

Specifically in relation to installation of heat pumps, the current approach of stimulating demand-side response from individual consumers via the domestic renewable heat incentive must learn from previous attempts such as the Green Homes Grant or they will inevitably fall foul of the same issues.

Q10. What evidence do you have of the barriers and potential solutions to deploying energy efficiency in the English building stock?

Lack of coordination, commitment, and direction from Government and local councils may act as barriers to deploying energy efficiency in building stock in the UK. In the Commission's Growth Across Nations report, it consistently called for long-term devolved funding to cities to develop local transportation schemes, stating that 'the most appropriate infrastructure measures will vary according to the characteristics and strategic needs of different places'. A similar argument could be made in the context of some areas of energy infrastructure. For example, appropriate measures for decarbonising heating in an area will depend closely on local circumstances such as building stock characteristics; the potential for load aggregation for district heating networks; and the proximity to relevant energy hubs or 'clusters'.

The YPP have undertaken research on analysis on how local area energy planning can be used as a means to better coordinate efforts to deploy energy efficiency in local building stocks. We held a roundtable with industry experts, as well as one to one interviews to supplement discussion. During these discussions, we found that:

- Effective solutions for local areas can be found by taking advantage of the assets that local area has (e.g. local renewable resources or building stock). These are often fragmented or small in scale, and are therefore best picked up by a locally-led planning approach.

- Participants noted that, like it or not, there are going to be decisions made at a local level that affect decarbonisation, and therefore why not try and formalise this into a process and integrate this as LAEP or similar rather than just leaving it to be chaotic.
- There is a lack of data and reporting on available on local assets (ie building stock. One participant suggested that Energy Performance Certificates (ECPs) could be used as a means to incentivise homeowners and landlords to increase energy efficiency in the GB building stock, but also as a way to track and collect data.

The Scottish Government has undertaken case studies and gathered data to inform Local Heat and Energy Efficiency Strategies (LHEES) which focusses on energy efficiency and heating in buildings, rather than the full range of local energy issues. We suggest the NIC consider lessons learned from these pilots.

Q11. What barriers exist to the long term growth of the hydrogen sector beyond 2030 and how can they be overcome? Are any parts of the value chain (production, storage, transportation) more challenging than others and if so why?

When The NIC is considering solutions to hydrogen, it must consider the whole supply-chain and key inputs into hydrogen solutions. For example, water companies are facing increasing pressure to reduce abstraction for environmental improvement and reduce consumption to manage water demand, but hydrogen production and CCS may introduce a significant new demand for water that is currently unaccounted for in regional plans.

Q12. What are the main barriers to delivering the carbon capture and storage networks required to support the transition to a net zero economy? What are the solutions to overcoming these barriers?

The water demands of a hydrogen strategy are currently unaccounted for in regional plans due to the lack of a clear energy strategy to inform scenarios. In line with our recommendations on adaptive planning, we suggest the industry must work together to develop applicable scenarios.

Additionally, the land requirement for bioenergy and carbon capture and storage plants can be quite significant, as highlighted in the NIC's 'Engineered greenhouse gas removals' paper. As discussed elsewhere in our responses, land requirements for such solutions need to be considered on balance with expected resultant land take from the NIC's recommendations and loss of biodiversity. Depending on the biomass planted and geographic location, this could escalate water resource problems. Additionally, there should be consideration on how this could change the agricultural markets such as inflating the cost of food if farmers are offered more to produce biomass for bioenergy than food production.

Q13. In what ways will current asset management practice need to improve to support better infrastructure resilience? Your response can cover any number of the Commission's sectors

Ageing infrastructure assets are a significant problem for asset managers. There are insufficient funds to replace all ageing assets, and to do would unacceptably carbon-intensive. We must instead optimise our existing infrastructure. Better decision-making procedures will need to be developed that optimise both operation and maintenance. Digitalisation of the infrastructure assets and networks is likely to play a significant role in this, reducing the need for physical interaction/inspection by asset managers which can be costly, dangerous, and disruptive to the infrastructure services. For example, sensing technologies have the potential to 'digitalise' physical infrastructure assets by providing remote information to asset managers on asset performance and condition. Computational models can even be used to generate a digital twin that can be linked to this sensing data. At its most powerful, data streamed from the asset could update the digital twin in real time, with the digital twin output then feeding directly into asset management workflows - e.g., to identify early warnings of deterioration, so that maintenance can then be scheduled before this progresses to a more serious level of damage, or even asset failure.

Such approaches could have applications in many areas of infrastructure that fall under the Commission's remit. In general, linking real-time data that captures asset/network performance to models that can inform

decision making has the potential to improve the efficiency, reliability, and resilience of these infrastructure systems through better asset management and operation.

One underlying issue with the interpretation of sensing data is that some attributes (e.g., material properties) of ageing infrastructure can be highly uncertain. Because of this, it would be significantly easier to monitor assets while they are healthy and detect changes in measurements that correspond to the progression of damage, rather than to wait until a certain asset is deemed at-risk or damaged before instrumenting it with sensors and then attempting to make physical sense of the resulting data. However, when assets are not yet of concern it may be difficult to justify the capital costs of a sensing installation. It may therefore be important to explore ways of incentivising proactive rather than reactive interventions at healthy assets, e.g., by studying the whole-life benefits of approaches such as infrastructure digitalisation.

Alternatively, when it is not possible to gather information on the state of assets prior to damage, it can be informative to compare their current performance to that of other assets of similar construction. Commonalities may be found across ageing infrastructure networks - e.g., in cases where a single engineer would have been responsible for overseeing construction of all the bridges along a certain railway route. However, today in the UK, infrastructure assets with common characteristics may be maintained by various bodies. For instance, some ageing railway bridges are part of the 'Historical Railways Estate' and so are maintained by Highways England instead of Network Rail. In situations such as this, it would be advantageous to encourage data sharing between the bodies responsible for maintaining these assets. The construction of, in this instance, a National Bridge Register - in which sensing data is commonly stored and accessible to asset managers at all relevant organisations - could allow for better comparison of similar structures.

Optimising when to intervene on asset health is one way to manage the whole life cost and carbon of an asset. However, asset owners need to better understand the changing hazards (due to climate change, cyber-attacks, changing energy systems), to manage asset health and impact to services.

Incentive regulation has worked well in the past (e.g., in the energy sector) to encourage asset managers to balance proportionate risks in maintaining network/asset resilience and reliability at a level valued by consumers, whilst not gold-plating the network.

Furthermore, asset owners must change their assumptions on asset management. We've seen in recent times that "exceptional events" are occurring more frequently than in the past due to climate change. As reported in the third Climate Change risk assessment, all energy-related infrastructure is at risk from the impacts of climate change, flooding, high and low temperatures, high winds, and electrical storms – all of which can all cause disruption to the energy network.

Vulnerabilities in the energy network can cause cascading impacts onto other infrastructure systems. The impacts will likely increase as many decarbonisation plans are hinged on a move to increased electrification (such as water and transport decarbonisation plans). Ensuring resilience in our energy network will be key to mitigating the impact of climatic events on our infrastructure systems and the public. Case studies of these linkages are provided in the CCRA3 Briefing – Energy Sector.

Sectors need to put their own adaptation measures in place and not only rely on climate defence infrastructure (such as drought resilience schemes, and flood and coastal defences) to be able to maintain services and the safety of their assets. There needs to be more of a move towards designing not only infrastructure assets for climate change, but infrastructure systems. By understanding the hazards, secondary hazards, and asset health together, asset owners can better manage risk.

Q14. What are the barriers to and solutions for expanding recycling capacity, both now and in the future to deliver environmental and net zero targets?

There is a significant need to prevent materials entering the waste and recycling streams in the first place. Reducing the volume of waste joining this system would help ease the current capacity issues. There is an opportunity to create green jobs and new infrastructure, by supporting a national scale reuse and refurbishment scheme. This exists on a discretionary basis in some recycling centres around the UK, but is

not provided with sufficient resource, capacity or marketing for it to deliver the impact it could. New skills in refurbishment and 'up-cycling' will be required.

Construction professionals complain that "they would love to use surplus from other sites but there is never enough of the right stuff, not at the right time, or they just don't hear about it". Market places are springing up to try and make excess material more accessible and are popular for domestic products (e.g., FreeCycle, GumTree, EnviroMate). However, for this to have a real impact, it must happen at scale. This will require investment in infrastructure to sort, store, market, and transport excess materials and reusable items. This could be a revolutionary movement, creating green jobs and tackling multiple aspects of the material supply, waste, and decarbonisation challenges we face.

To fund investment in such an initiative, the cost of 'waste' must go up, disincentivising 'disposal' and supporting 'reuse'. The longer we are able to keep material in operation, the less raw material we will need to extract and process, and the less waste we will ultimately have to deal with.

Q15. What is the likely environmental impact of waste streams from construction across economic infrastructure sectors, over the next 30 years, and what are the appropriate measures for addressing it?

With ageing infrastructure and housing stocks, we have a choice to make. We need to invest in maintaining and upgrading significant portions of our national infrastructure, or risk needing to demolish and rebuild at scale (generating huge amounts of waste and consuming high carbon materials).

Waste management is still a major challenge for construction sites, with many still opting for mixed skips instead of carrying out effective waste separation on site. In some instances, this is driven by space constraints, however in many others it is down to poor waste education / awareness and limited incentives to properly separate waste.

This, however, is not the most significant issue. It is preventing the waste being generated in the first place. With approximately 13% of all materials delivered to site being sent to waste **without** use (according to data from the UKGBC), it is our materials management that poses the most significant risk.

Greater standardisation of design to reduce the ad hoc cutting of materials on site could dramatically reduce waste, and reduce project programmes and safety risks. This is not a proposal for a built environment made up entirely of identical boxes, but one that allows for creativity within a sustainable, de-constructable, modular sphere. There are some fantastic companies experimenting with this including Biohm. This is also in line with the latest vision of platform construction put forward by the Infrastructure and Projects Authority.

A combination of economic incentives can make it less economically favourable to demolish and start again and more favourable to use existing infrastructure – either repurposed, or deconstructed and reformed. Design and planning will need to adapt to accommodate this, with design for deconstruction taking a lead, and more sensitive and holistic planning allowing for greater flexibility of space.